

Investigate the Surface Water Quality Parameters for Domestic Supply

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Abstract: The quality of surface and ground water is a very sensitive issue in the context of any country, especially as it is a major factor which affects human health as well as ecological systems. According to Environmental Protection Agency's (EPA) report, ground water in several parts of the country is deadly polluted to arsenic. Furthermore, it is also found that pond water of Rajshahi city is being contaminated gradually due to the dumping wastes. Therefore, surface water quality analysis is necessary to employ it as household applications. For qualitative analysis, this study has analyzed different water quality parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Alkalinity, Iron, Turbidity, Color, Total, Suspended and Dissolved solids (TS, TSS, TDS), pH, and Free Chlorine of different ponds situated at Rajshahi city, Bangladesh through standard methods. This research finds that, a number of quality parameters of water are failed satisfy to WHO and BDSW standards for BOD, COD, Turbidity and Iron. Conversely pH, Color, Free Chlorine and Alkalinity are meet the standards. Moreover, the experimental result reveals that high value of turbidity (16.5 NTU) and BOD (12 mg/L) are present on the pond water sample. So pond water of Rajshahi City can be used for drinking or cooking purposes if and only if it is properly treated or purified.

Keywords: *Surface water; pH; BOD; COD; Turbidity; TDS; Alkalinity*

Introduction: Bangladesh is a developing country and recently this country is suffering from critical crisis of pure drinking water due to severe pollution and depletion of groundwater and surface water sources throughout all parts of it. Every living being, especially we humans are dependent on fresh water sources on a daily basis. That is why the problem regarding the pollution of this source has got special importance.

It is about time that we started looking for alternative sources of fresh water for drinking purpose and we cannot but take surface water into consideration as options are limited. Analyzing the quality of surface water sources is essential for this purpose. Ponds are one of the most important and common sources of surface water used for various domestic purposes. Unfortunately this source is being polluted daily in many ways. Consequently the water quality of the source is also degrading. According to the Rajshahi Development Authority (RDA), in 1961, there were 4238

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The municipal water supply in Bangladesh is not sufficient compared to the demand. The water supplied by the city corporations is limited both spatially and temporally. As a result, many people are forced towards using hand pumps and sometimes, surface water also. Quality of which still remains a question [2]. The problem is fueled by improper and unplanned construction of drainage system. Previous researches have shown that unplanned distribution of drainage system has rendered much difficulty for sewage flow in the city [3]. Researches also show that the water quality parameters of rivers nearby to Rajshahi are not suitable for drinking purpose [4], but can be used for other purposes such as fisheries, irrigation, etc. [5]. The nature of groundwater is alkaline around Rajshahi with iron and bi-carbonate as major cations and anions [6]. Previous research on water quality parameters of the Padma river and also tube-wells in Rajshahi show that the levels of hardness related to iron, arsenic, manganese etc. are well above the permissible limits for drinking [7]. Moreover, industrial and municipal wastes have overwhelmed the ponds of Rajshahi city [8]. The situation is worsening day by day due to unplanned drainage, garbage dumping and out of date waste management system [9]. As a result, risk of waterborne diseases like diarrhea, cholera, etc. is increasing over the years [10]. Waste water is seen to be reused in some places in agricultural purposes as they possess some properties of some pesticides and fertilizers, it still possess huge health risks [11]. The ponds are also getting polluted by human and animal excreta, seepage from pit-latrines and other domestic wastes too [12]. Another research shows that the primary reason behind the contamination of pond water is regular discharge of domestic sewage such as kitchen waste, washing clothes, bathing; etc. [13]. The impact of using such polluted source of water for drinking purpose is undoubtedly harmful for humans. Microorganisms such as planktons are harmful for both human and aquatic life. Turbid water is aesthetically unacceptable to humans, which is mainly caused by runoff from localities near the ponds [16]. Review of previous research has shown that a qualitative analysis is required for analyzing the surface water sources [17,18]. This research has aimed to determine the rate of pollution of various ponds in Rajshahi city by comparing the water quality parameters of selected ponds with national and international standards. The parameters are Color, Turbidity, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total solids (TS), Total Dissolved Solids (TDS), Total suspended solids (TSS), pH, Alkalinity, Iron, Free Chlorine, Dissolved Oxygen (DO), Etc.

Almost all the countries in the world follow either their own or international standards for maintaining the quality of water for use. In the US, the US Public Health Service (USPHS) started setting standards for Drinking water that is supplied to the public since 1913. In 1970, this objective was transferred to the USPEA. In 1980, the European Community Directives was issued which set the standard quality parameters for drinking water in Europe. In our country, we mainly follow two standards. First is the guidelines provided by World Health Organization (WHO) published in 1958 and second, the Environmental Conservation Rules (ECR)/(BDSW) published in 1997. This research is performed in accordance with the WHO and BDSW standards. In recent times, Bangladesh has faced severe crisis of fresh water sources as a result of pollution and also depletion of ground water level throughout the country. This has severe and

complex effects on human and animal health and also the environment. Many researchers have showed that the Ground water is severely affected by arsenic in many parts of our country. So it is about time that we started looking for alternative sources of drinking water to reduce the pressure on ground water and also allow ground water tables enough time to recharge.

Literature review has showed that there have been many researches on pond water quality throughout the world. However it is less likely that the results from different parts of the world would be comparable. Very few research works has been done on the ponds of Rajshahi city. This research aims to investigate whether different water quality parameters like Iron, Free Cl, BOD, COD, Alkalinity, Turbidity, pH, Color, DO, Total Suspended Solids, Total Dissolved Solids and Total Solids in a number of ponds in Rajshahi city are in accordance with the Standard values.

Methodology: To conduct this study, water sample from fifteen different ponds spread throughout the city were collected. The sample was later tested for different parameters at the Environmental Engineering and Chemistry Lab of Bangladesh Army University of Engineering and Technology (BAUET), Natore, Bangladesh and Institute of Environmental Science (IES) research lab at Rajshahi University, Rajshahi, Bangladesh.

Study Area: Rajshahi City Corporation lies in the north-western part of Bangladesh and is one of the biggest city corporations. It is situated between 24°21' and 24°26' north latitudes and 88°28' and 88°37' east longitudes. The east, north and west part of the city is surrounded by Pabathana and the south side is bounded by Padma River. The overall shape of the city resembles an inverted “T” and the area is about 47.78 sq. km. which is spreaded in the east-west and north-south direction is about 13 and 8 kilometers [15].

Sample Collection Area: There are 30 wards in RajshahiCity Corporation. The sample water is collected from 15 separate ponds from 15 separate wards.

Table 1. Details of Location and Owner of the Pond

Ward No.	Description of Pond
01	Horogram Guripara Pukur, Mouja: Horogram, Name of Owner: City Corporation
04	Bulonpur Turning Pukur., Mouja: Bulonpur, Name of Owner: City Corporation
06	Paramedical Pukur, Mouja: Laxmipur Name of Owner: Paramedical Authority
07	Rajshahi Central Zoo Pukur. Mouja: Rajshahi Central Zoo Name of Owner: City Corporation
09	Loknath School Pukur, Mouja: Rajshahi Loknath School Name of Owner: Loknath School Authority

13	Kadirganj Sobhan bag Dighi, Mouja: Boalia, Name of Owner: AbdusSobhan
15	Sukna Dighi Pukur, Mouja: Sapura, Name of Owner: Public
16	Moth Pukur, Mouja: Sopura, Name of Owner: BSCIC
20	Lathial Mondop Trust Pukur, Mouja: Seroil, Name of Owner: Lathial Mondop
21	Seroil Pukur, Mouja: Seroil, Name of Owner: Abul Kashem
23	Bosepara Kali-Pukur, Mouja: Bosepara, Name of Owner: Abdus Samad Mia
26	Vaudra Park Pukur, Mouja: Vaudra Park, Padma Residential Area, Name of Owner: R.D.A
27	Moth-Pukur, Tikapara, Mouja: Tikapara, Name of Owner: Public
29	Dasmari Rahmat Shah Pukur, Mouja: Dasmari, Name of Owner: Rahmat Shah
30	Rokeya Hall Pukur, Rajshahi University, Mouja: Rajshai University, Name of Owner: Rajshahi University

Sample Collection: The collection of water sample was performed as the following step: Samples collected in plastic bottles which were washed with 2% nitric acid after being kept in detergent solution in 24 hours and rinsed. Before sampling, 0.5gm of ascorbic acid was added to the bottle after cleaning. Sample was collected from 1ft below the surface of the ponds. The samples were stored at a dark place with temp kept at 4°C.

Sample Compilation and Storage: Analysis was performed as soon as possible to prevent the effect of delayed residual effect of bio-chemical activities in sample water. Sample was maintained at 4° C and the sample bottle was not opened until the analysis was performed.

Results and Discussion:

Measurements of Water Quality Parameters:

Iron: Iron in water is often consisting with widespread iron bacteria. Basically, iron bacteria are tiny creatures that inflate the discoloration, pipe blockage and some other related problems. As expected, the value of iron varies from 0.10 mg/L to 0.30 mg/L among 15 wards. Furthermore, iron value is as low as 0.3 mg/L has been measured which is in compliance with World Health Organization and Bangladesh Drinking Standard [18]. From the experimental data graph, it is comprehended that the value of iron in the entire pond in Rajshahi are 0.10mg/L \approx 0.30 mg/L, likewise this is also in the acceptable limit.

Thus, this water can be used for various purpose including consumption, recreation, fishing, irrigation, clothing sponge down etc. where if only if iron contamination is considered.

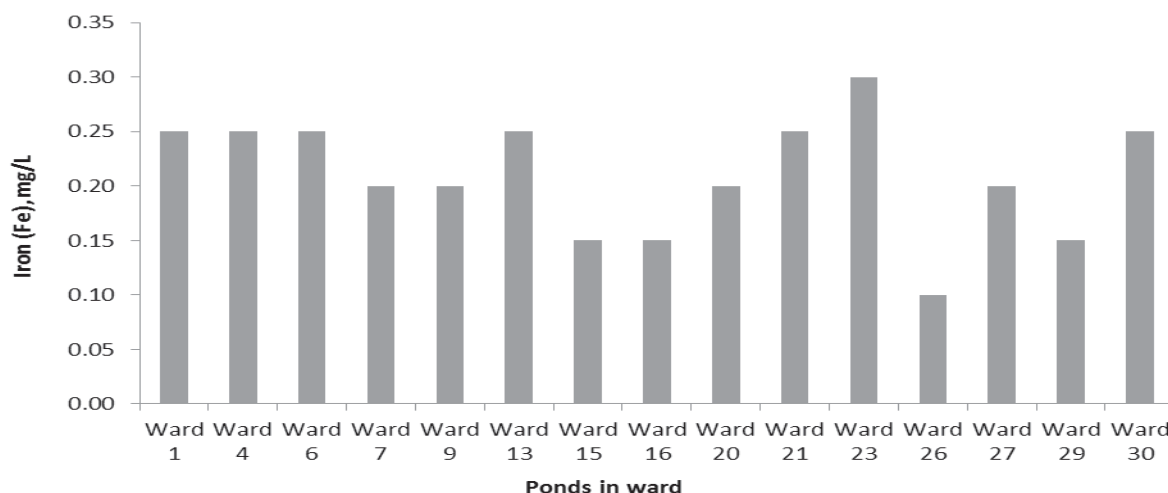


Fig. 1: Measured iron variation over different ponds for Rajshahi city corporation, Bangladesh. This is an example of average iron variation of the northern region of Bangladesh. The unit is measured in mg/L

Free Chlorine: According to BDWS and WHO standard, the water is drinkable only, when the value of free chlorine is 0.2 mg/L [18]. Likewise, from the Fig. 2, it is observed that the amount of chlorine for all the pond water is below 0.30 mg/L. Therefore, considering chlorine contents, this pond water is also fitting for consumption as well as irrigation and other purposes. Furthermore, this bar chart also reveals that, the rates of discharge is maximum in ward no 26 and minimum in ward no 06, 09, 13, 16, 23, 27 and 30.

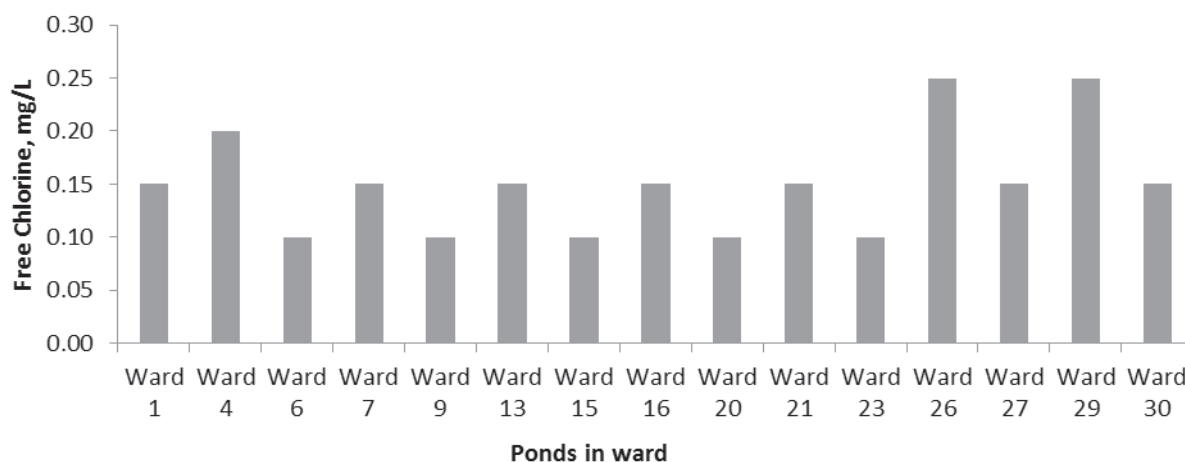


Fig. 2: Measured Free Chlorine variation over different ponds in different wards in Rajshahi city corporation, Bangladesh is shown in the bar chart. It signifies that, most of the pond water satisfies the standard limit of free chlorine for drinking purpose. The unit is measured in mg/L

Biochemical Oxygen Demand (BOD): Basically, Biochemical Oxygen Demand (BOD) value is used to determine the biological activity of the micro flora and characterization of the water. It is also employed to determine the biological capacity of a sewage water treatment plant. In addition, according to the Bangladesh Drinking Water Standards (BDSW), the permissible limit of Biochemical Oxygen Demand for drinking water is 0.2 mg/L and for the other purposes it will be 5mg/L or less. At the commencing of the Fig. 3, it is distinguished that Biochemical Oxygen Demand value of each pond in every ward remains in safe and sound zone. However, the Pond water normally not be used for drinking purposes, whereas it can be used for irrigational and fishing purposes.

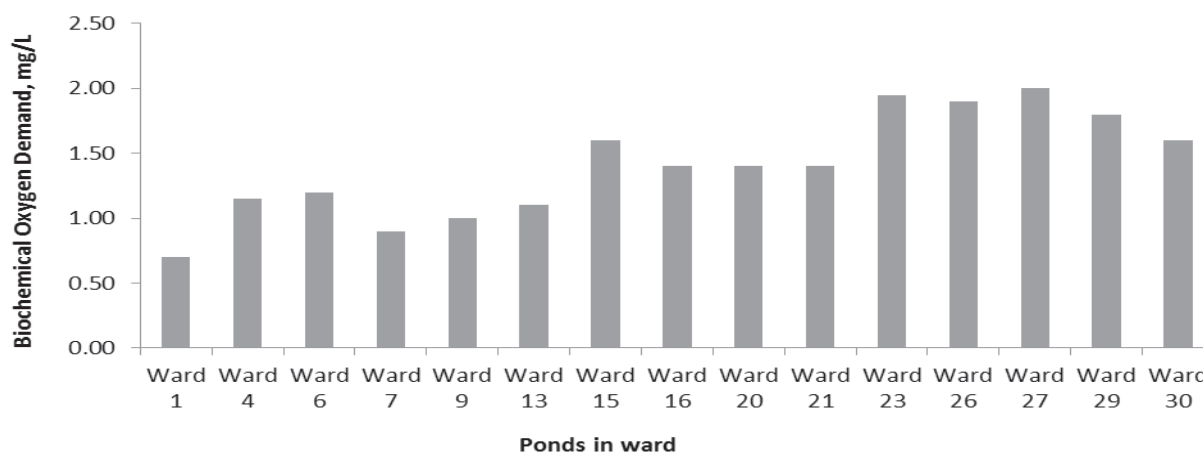


Fig. 3: Measured Biochemical Oxygen Demand (BODs) variation over different ponds in different wards in Rajshahi city corporation area, Bangladesh

Chemical Oxygen Demand (COD): Basically, the value of COD is categorized from 4.20 mg/L to 9.10 mg/L. According to the Bangladesh Standards, the permissible range of COD for consumption purposes should be 4mg/L. Therefore, our measured value is not equivalent to the Bangladesh Drinking Water Standards. However, it is worth to mention that, the COD value is highly increased in the Ward No.7.

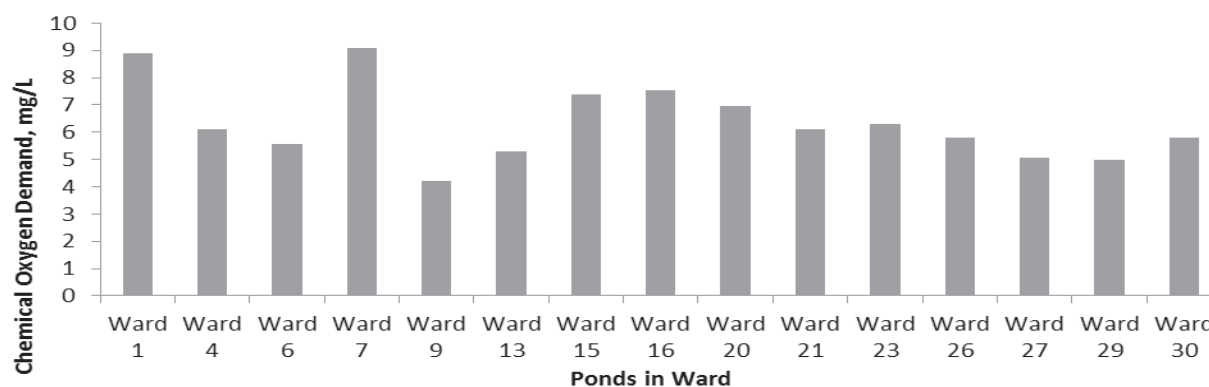


Fig. 4: CODs variation over different ponds in different wards in Rajshahi city corporation area Bangladesh. The unit is measured in mg/L.

Alkalinity: Basically, the value of Alkalinity is categorized from 70.50 mg/L to 115.45 mg/L. According to the Bangladesh Standards, the acceptable range of Alkalinity for consumption purposes should be 120 mg/L. Therefore, our measured value is within the acceptable level as considering the Bangladesh Drinking Water Standards.

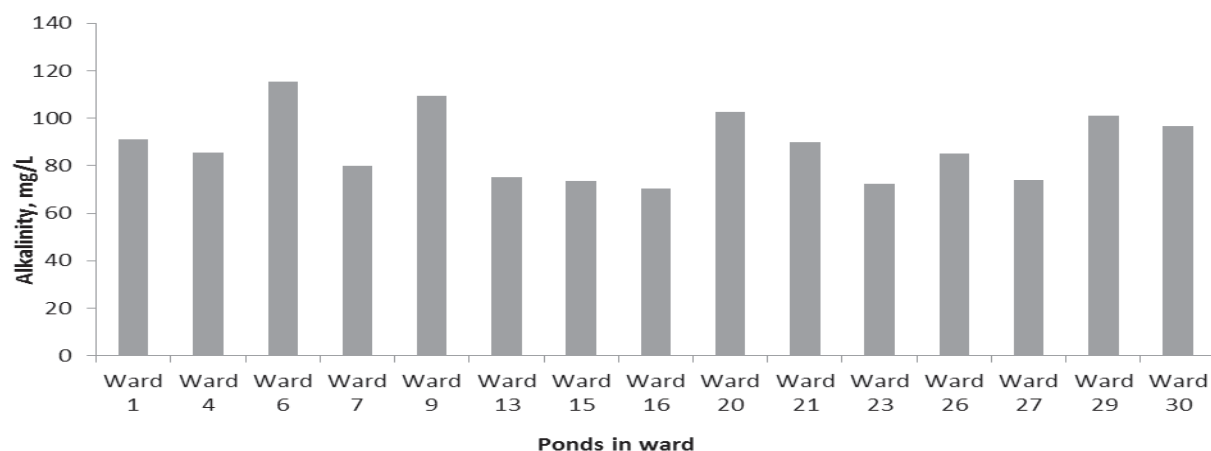


Fig. 5: Measured Alkalinity variation over different Ponds in different wards in Rajshahi city corporation area, Bangladesh.

Turbidity: Turbidity is the muddiness of water consisting with a large numbers of individual particles. This is generally invisible to the naked eye. The measurement of turbidity is a prime way to evaluate the water quality. According to the Bangladesh Drinking Water Standards, the typical value of turbidity should be in between 5 NTU to 10 JTU. Following the guideline of WHO (1993), the typical value of turbidity supposed to be 5 JTU [18]. Likewise, from the Fig. 6, it is observed that, most of the sample restrains the turbidity more than 5 mg/L. As a consequence, the results suggest that this water should be treated prior to domestic usage whereas it can be utilized in other uses as well.

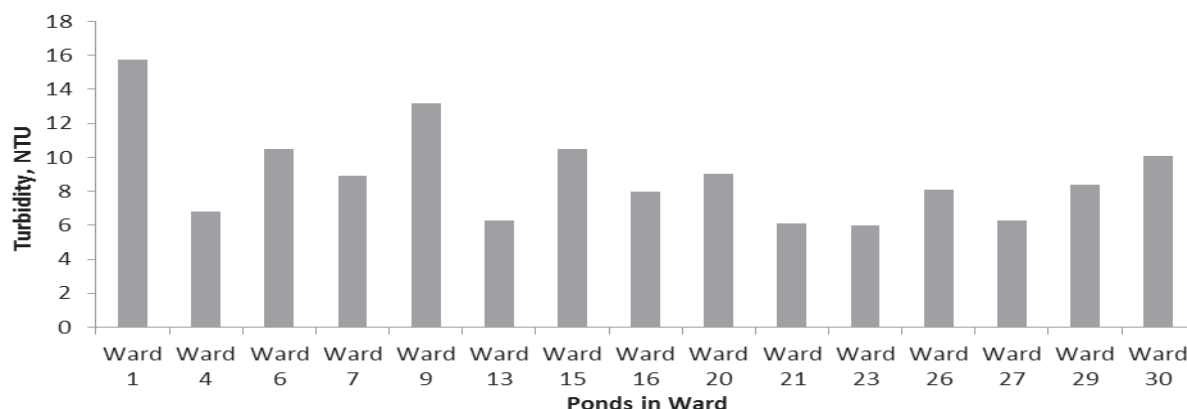


Fig. 3: Measured Turbidity variation over different ponds in different wards in Rajshahi city corporation area, Bangladesh.

p^H: According to WHO and BDWS, the standard value of p^H for drinking purpose lays in between 6.5~ 8.5. This is standardized that, if the value of p^H is below 6.5, it turns into acidic. Principally, the p^H value of neutral water is equal to 7. Furthermore, according to experimental data it is clearly seen that the value of p^H varies from 6.50 to 8.50.

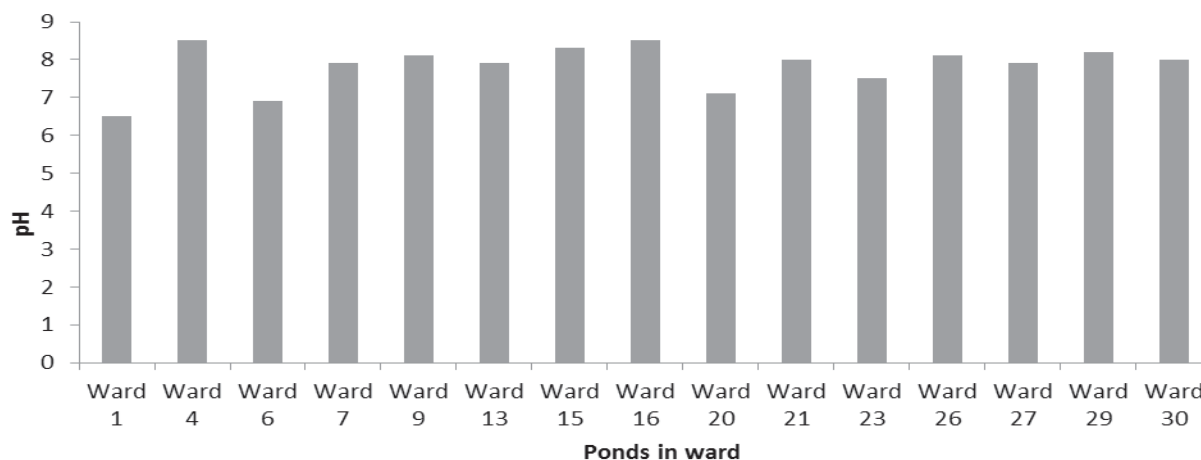


Fig. 7: Measured p^H variation over different ponds in different wards in Rajshahi city corporation area, Bangladesh.

Color: Mainly, color of the water primarily depends on the presence of colored organic metal substances that resembles iron, manganese or highly colored wastes. According to BDWS and WHO, the typical value of color varies from 0.05 to 0.20 Hazen unit. In this work, the results profoundly indicated that, as a source of drinking water the values of color of 15 ponds are in the permitted level.

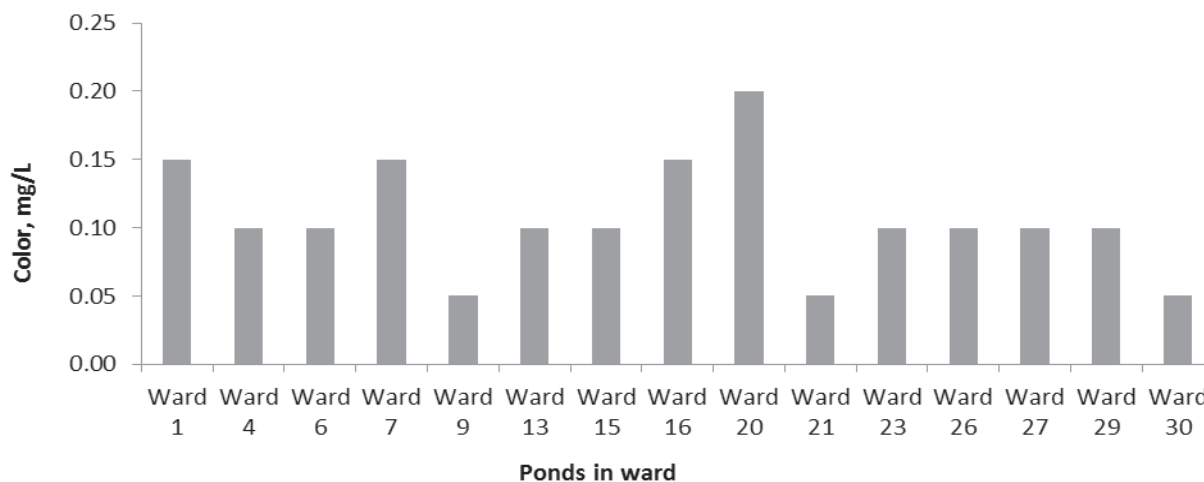


Fig. 8: Measured Colors variation over different ponds in different wards in Rajshahi city corporation area, Bangladesh.

Dissolved Oxygen (DO): It is regarded by Standards from the Environmental Conservation Rules 1997 is that, for drinking point of view the standard Dissolved Oxygen (DO) value must be 6 mg/L or above and as well as for other purposes like irrigation, fisheries, and recreational activities the DO value must be 5 mg/L or above. From the data graph, it is observed that the DO value of every sample is less than 6mg/L, so it shall not be used for drinking purpose but it can be used for other purposes such as irrigation, fishing etc.

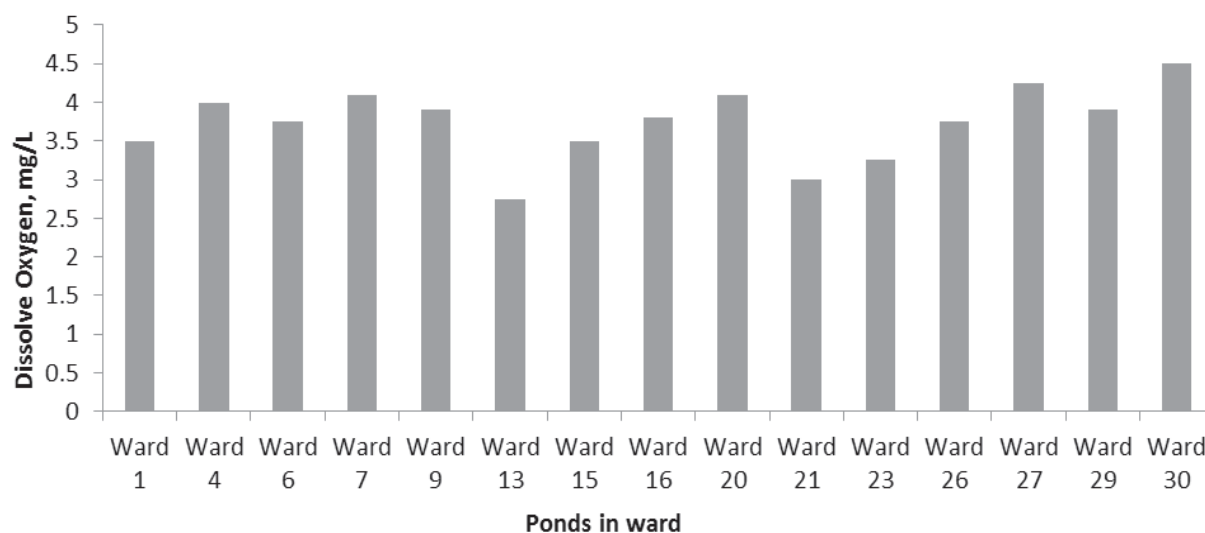


Fig. 9: Measured Dissolved Oxygen (DO) variation over different ponds in different wards in Rajshahi city corporation area, Bangladesh.

Total Suspended Solids (TSS) and Total Dissolved Solids (TDS): According to Bangladesh Drinking Water Standards, the standard limit of TSS for drinking water is 10 mg/L.

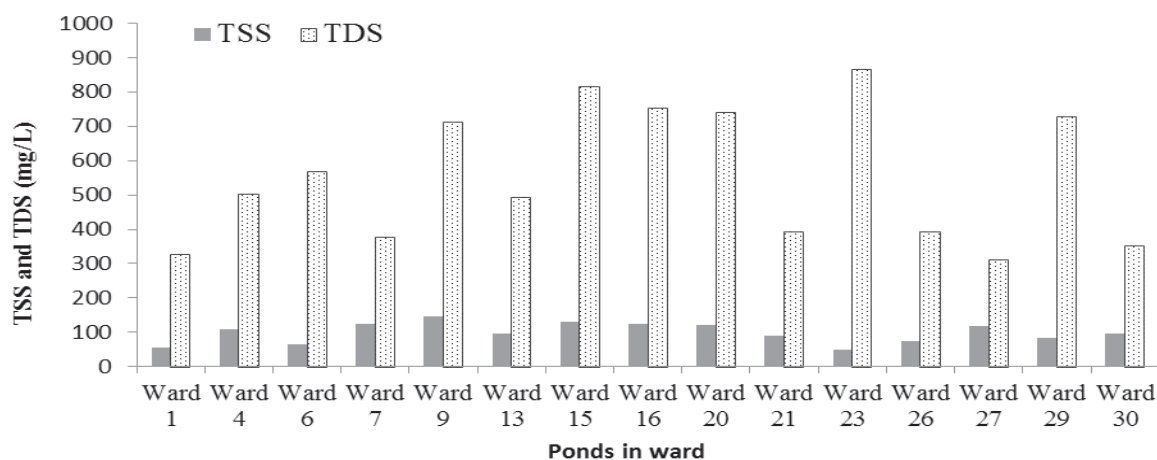


Fig. 10: Measured TSS and TDS variation over different ponds in different wards in Rajshahi city corporation area, Bangladesh.

In case of TSS, it is found that the pond water is not suitable for drinking. Most prominently, the total dissolved solid for all the sample is less than 1000 mg/L, which is up to standard. Furthermore, in case of Ward number 23, it is found that the total dissolved solids are highest among the entire pond water sample.

Total Solids: According to BDWS, the acceptable limit of Total Solid (TS) for drinking water is round about 500 mg/L and for other purposes it would be 1000 mg/L. From the experimental data, it is profoundly observed that, the value of Total Solids (TS) is more than 500 mg/L which is not suitable for drinking purposes. Nonetheless, in the few pond Total Solids (TS) value is less than 500 mg/L.

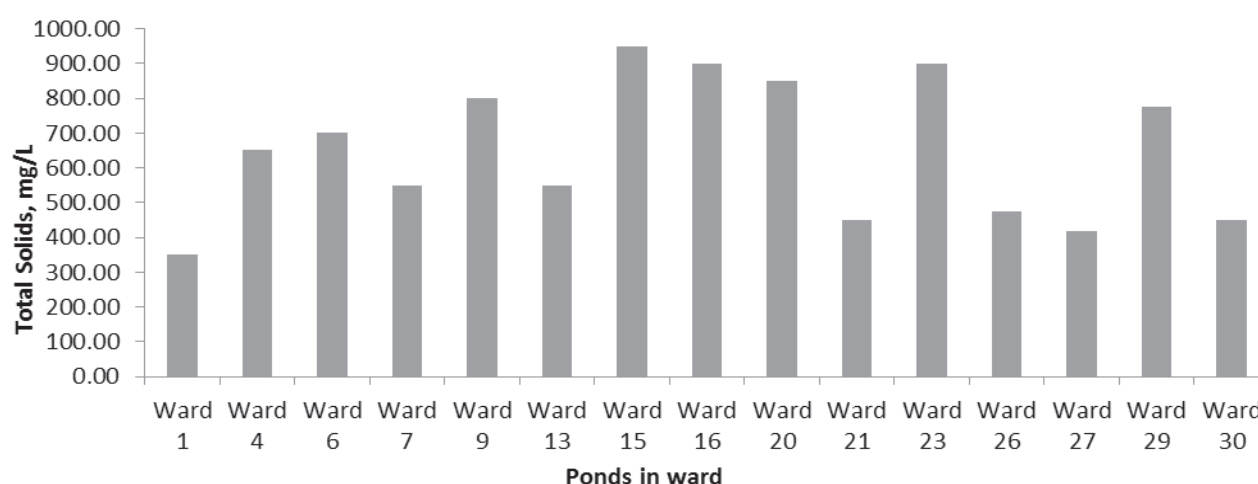


Fig. 11: Measured Total Solids (TS) variation over different ponds in different wards in Rajshahicity corporation area, Bangladesh.

Conclusions: In this research, the water quality parameters over different ponds in Rajshahi city, Bangladesh is analyzed. It is found that some pond water is suitable for consumption considering pH, color, chlorine and alkalinity. However, values of BOD, COD, turbidity and iron content are not up to WHO and BDSW standards. Moreover the experimental result shows that the water quality parameters in the ponds of Rajshahi city are degrading due to human activities. The outcome of the research suggested that in case of human, environmental impact assessment (EIA) need to be considered. It can be concluded that the water from all the pond is not safe and sound for drinking purpose. Nevertheless, the existing facilities can be covered only 56% of the total water demands of Rajshahi city. For covering up 95%, sufficient surface water treatment plant is essential. Basically, the ponds must be protected from wastewater discharge to use the pond water as an alternative source of domestic water supply.

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